A Survey on Non-Residential Solar Water Heaters in Taiwan: Barriers and Strategy

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Abstract: Among various forms of renewable energy, solar thermal energy is the most wide spread use in many countries. Taiwan's climate is subtropical, which is ideally located to take advantage of solar thermal energy technologies. Taiwan began the manufacture of SWH in 1978. However, the number of installed SWH is quite limited because of high capital cost compared with the conventional ones, e.g. LPG or natural gas heaters. To the development of indigenous alternative and renewable energy resources, the subsidy programs (1986-1991, 2000-present) have been established for solar water heaters in Taiwan. It was found that the subsidy programs were obviously critical for promotion of residential solar water heaters. The installed area of solar collectors increased significantly, and was up to 1.79 million square meters in 2008. Almost all the installed solar collectors are used for hot water production for the homeowners (residential systems), in which mainly the area of solar collectors is less than 10 square meters. From 2001 to 2008, there were only 2,707 non-residential systems (over 10 m^2) installed. They are for hotel, hospital, showering of rooming house (dormitory), swimming pool, and manufacturing plants. A comprehensive survey of those non-residential solar water heaters was conducted. The objective of the survey is to evaluate the comments from the end users. Thus the decision makers in the energy sector might make use of it in their rational decision making process of implementing more compressive programs to prompt the installation of non-residential solar water heater in Taiwan.

Keywords: solar water heater, subsidy, non-residential, barrier, strategy,

1. INTRODUCTION

Although the intermittent nature of renewable energy resources, they are a sustainable and clean energy asset derived from nature. Other than the net energy saving, the environmental benefits are reduction in the production of air pollutants and release of greenhouse gas into the atmosphere. The major resources include solar energy, wind energy, geothermal energy, ocean energy, biomass, and energy from waste. For the development of indigenous alternative and renewable energy resources, the Taiwanese government initiated subsidy programs on solar water heaters (SWHs), solar photovoltaic systems, resource exploration of geothermal power demonstration systems and energy crop green bus projects. A Renewable Energy Development Bill has been submitted for ratification to establish a legal environment for renewable energy [1]. It is expected renewable energy will count 3% of the primary energy supply by the year of 2020 in Taiwan.

SWH has been proved to be reliable and economical in cases of hot water production, and is also the most successful story for the development of renewable energy in Taiwan [2]. The accumulated area of solar collectors installed at the end of 2008 reached 1.79 million square meters. In this context, Taiwan has a lot of experience in the SWHs market. However, there were over 98% SWHs with the area of solar collector (ASC) less than 10 m^2, which is considered as the residential systems. From 2001 to 2008, there were only 2,707 non-residential systems (ASC > 10 m^2) installed. In addition, the local market is nearly frozen over the past three years. Thus, the present study is devoted to the evaluation of barrier and strategy on promotion of non-residential SWHs in Taiwan. This information would be useful for all parties related to this market, manufacturers, potential users and policy makers.

2. SWH MARKET IN TAIWAN (2001-2008)

To the development of indigenous alternative and renewable energy resources in Taiwan, the subsidy programs (1986-1991, 2000-present) have been established for SWHs. As shown in Fig. 1, it is clear the subsidy programs were obviously critical for promotion of SWHs. In 2001, there were nearly thirteen thousand SWHs installed. With the subsidy program, the SWHs installed were over twenty-four thousand units in 2006. The area of solar collector (SC) installed per year also increases up to 124,000 square meters in 2007. However, in 2008, the global financial crisis has a strong impact on the local market. The annual area of solar collector installed decreased about 5%.

In the present incentive program, each SWH users should provide address and specifications/price of product. This essential information about the system is then statistically analyzed to generate the regional distribution of SWHs in Taiwan. Further, the field research based on the use of a number of questionnaires has been conducted. SWH owners were approached through person-to-person interviews. These questionnaires consisted of questions on (a) the attitude towards SWHs; (b) main technical problems; (c) installation location; (d) year of completion of housing construction; (e) household composition. In addition, according to ``Guidelines for promoting Solar Hot Water Heaters '', a layout of a large-scale system (ASC > 65 m^2) is required. A review committee then evaluates the system performance based on some design criteria, e.g. local weather conditions (sunshine hours, insolation and temperature), thermal efficiency of solar collector, piping (thermal insulation), storage tanks and auxiliary equipment. The comments from reviewers can

assist the installer to revise the system design.

A general survey on SWHs' users has been conducted since 2001. The data of SWH installation in terms of ASC is shown in Table 1. Most systems (about 98%) had ASC less than 10 m^2, which is considered as a residential system. This agrees with the household structure of SWH users [3]. One-person households account for less than 1% of SWH users, and the family size of 4-6 persons is more positive in installing a SWH (nearly two-third of the users). Larger SWH systems designed for more than 9 persons accounted for 11.25% in the SWH user composition. In addition, the market survey indicated the share of evacuated tube type solar collector expanded greatly recently and its average installed area was less than that of flat plate type. This should be attributed to more systems with ASC less than 3 m^2 (over 16% from 2006-2008). It is also noted that the units of residential system increase within the current subsidy program, but not for larger scale systems. There are only 67 SWHs with ASC over 100 m^2 during the past eight years. Thus the government needs to develop new strategies, and promotion of larger scale SWHs should be addressed.

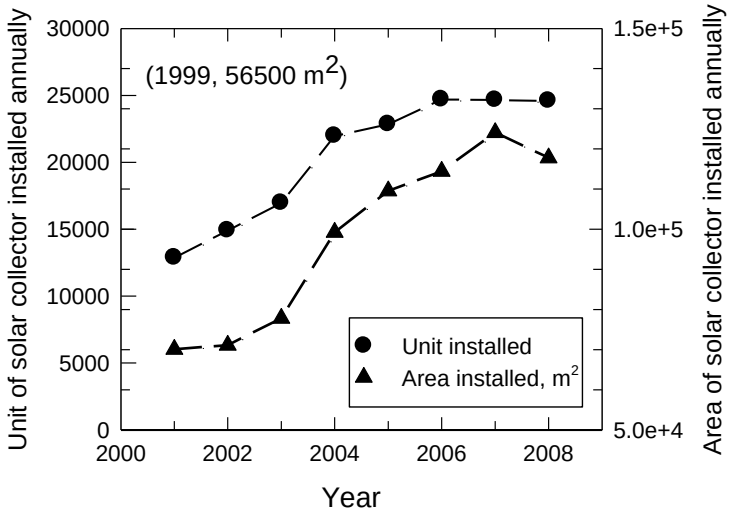

Fig. 1 SWHs installed from 2001 to 2008

Table 1 Installation of SWHs in terms of area of solar collector

A_c, m^2	Below 3	3-5	5-10	10-100	Above 100	Total
2001	1,192	5,504	5,880	277	8	12,861
2002	1,979	6,236	6,346	320	6	14,887
2003	2,114	7,310	7,176	352	4	16,956
2004	2,983	9,220	9,409	349	9	21,970
2005	3,227	9,688	9,581	326	8	22,830
2006	3,988	10,468	9,913	303	12	24,684
2007	4,174	11,134	8,980	354	4	24,646
2008	4,030	11,524	8,662	359	16	24,591

3. NON-RESIDENTIAL SOLAR WATER HEATERS

The household structure in Taiwan is shown in Fig. 2. One-person households have stood at the highest level among the total households, which the share of one-person households increased from 23.4% to 27.6 % from 2001 to 2008. The two-person to four-person households dominated the household composition in 2008 and stood at 53.6% while the households with six persons or more only accounted for less than 10%. As a thumb of rule for system design of a SWH in Taiwan, the daily hot water consumption for each person corresponds to the hot water production by 1 m^2 solar collector. Thus it is considered SWHs with the area of solar collector larger than 10 m^2 would be more likely used for the commercial sector. In Fig. 3, it can be seen the commercial systems installed per year are roughly the same during the past eight years, which ranged from 300 to 400 systems. Furthermore, the application of those SWHs can be classified into three groups. The SWHs for rooming house/dormitory accounts for over 98% systems installed. There were only 16 and 11 systems for manufacturing plants and swimming pool (Fig. 4), respectively. A few systems were designed for restaurant applications. Then in terms of area of solar collector installed, the SWHs of 10-20 m^2 accounts for over 76% while the SWHs over 60 m^2 is only 5%, as shown in Fig. 5.

For the person-to-person interview, 136 users of commercial system were approached. The survey indicated the energy saving is the primary concern for the end users. In addition, more than 95% of the SWHs had an electrical booster pump installed, so most of the systems are capable of safely supplying hot water. The survey also showed nearly 80% of the SWHs were installed on the roof of buildings while the other 20% systems sit on the tilt roof.

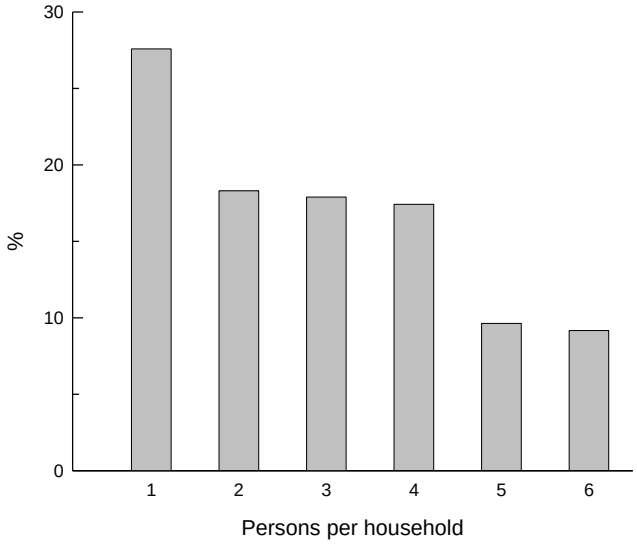

Fig. 2 Household structure in Taiwan, 2008

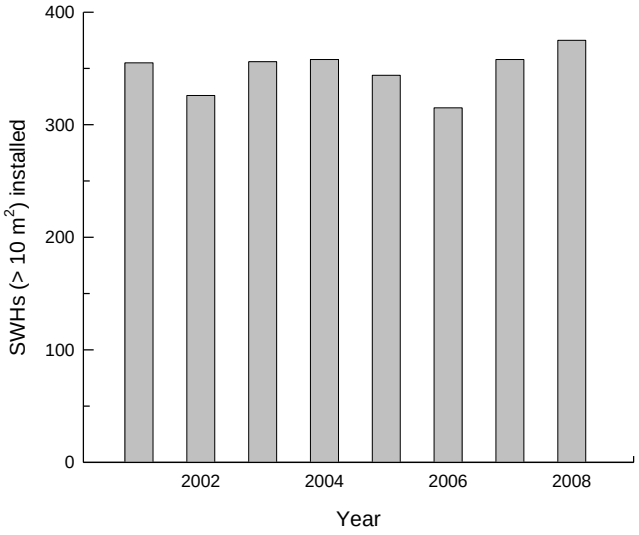

Fig. 3 Larger SWHs installed

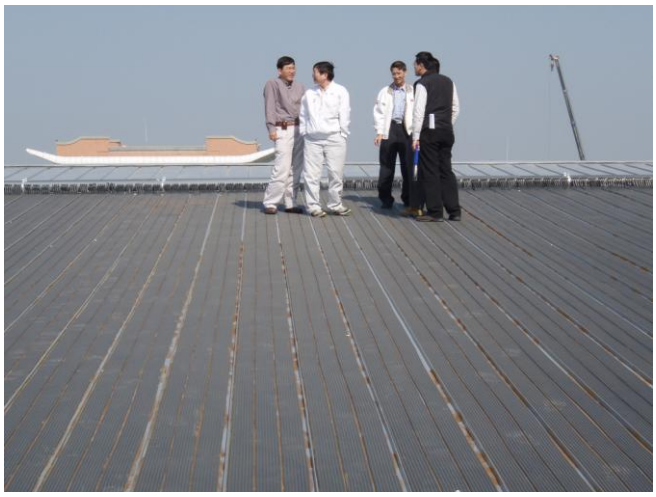

Fig. 4 SWH for swimming pool

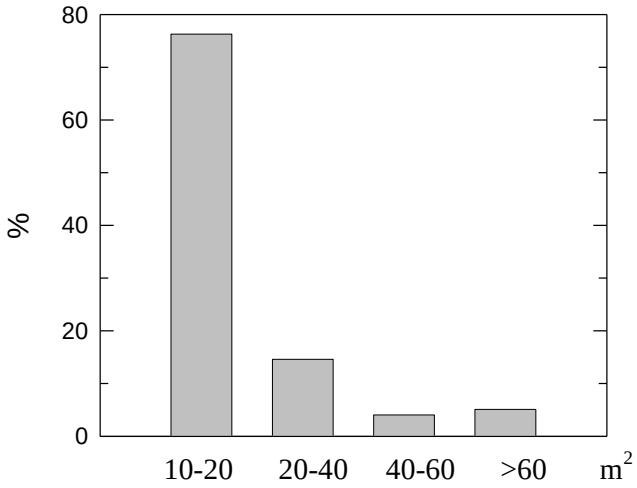

Fig. 5 SWHs in terms of area of solar collector area installed

4. BARRIER AND STATEGY

It is known the ownership and architectural type of buildings would limit the available area for SWHs installation. As mentioned above, almost all SWHs were installed on the roof of buildings. However, the two- to five-story buildings accounts for over 70% buildings in Taiwan, and the roof would be also used for other purposes. Thus there is limited space for the installation of SWHs (including solar collectors, water storage tank, and piping). This would be a more critical issue for a larger system. Thus the related architectural laws should be amended toward the installation of SWHs, in which government regulation should be implemented forcing builders to incorporate SWHs in the building design. In addition, a larger scale SWH (dormitory or rooming house) is usually integrated with kerosene heater as an auxiliary hot water supply. The technical problems like pipe routing and higher installation cost might be the other major barrier for SWH installation. Regulation of hot water supply is also considered to be associated with the reduction in cost of fuel. For a swimming pool with SWHs, the proper system design is related to the local temperatures at different seasons. Since Taiwan's climate is subtropical, overheating could be the major concern in summer. On the other hand, larger scale SWHs would benefit from the effect of scale based on economic concerns. The unit price of flat-plate and evacuated-tube types of solar collectors is shown in Table 2. It can be seen the unit price of a SWH decreases with larger area of solar collectors installed, particularly with flat-plate type solar collectors. Compared with smaller SWHs for one-person households (below 3 m^2), the unit installation cost in a larger scale system (A_c > 10m^2) can be nearly 45% off and thus the payback period is expected to decrease.

Table 2 Unit price in terms of solar collector area (NT$/$m^2$)

A_c, m^2	Below 3	3-5	5-10	10-100	Above 100
Flat plate	12,527	8,659	6,181	6,870	7,003
Evacuated tube	8,726	7,420	6,932		

5. CONCLUSION

The commercial SWHs are quite limited in Taiwan (less than 5% market share). Available installation location would be the major barrier. Consequently, most installers are lack of experience in system design of larger scale SWHs. Reliability of system operation is another concern. In addition, overheating in summer time should be further addressed in designing a system for swimming pool. A comprehensive guideline on system design is required. Finally, most larger scale SWHs installed were used for dormitory or rooming house. In terms of efficiency, the systems for manufacturing plants will result in the most benefit in comparison with other application. Further efforts should be done.

The global financial crisis in 2008 has certainly a strong impact on the local SWH market. Although the Taiwanese government increases 50% of the subsidy, the area of solar collector installed is still in decline. To boost the local SWH market, it is thought the government should put more efforts on the pubic sectors, namely rooming houses or dormitory for public schools, military bases and governmental agencies.

6. ACKNOWLEDGMENTS

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7. REFERENCES

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